Bats of Ravenna Training and Logistics Site, Portage and Trumbull Counties, Ohio[1]

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ABSTRACT. Six species of bats (*n* = 272) were caught at Ravenna Training and Logistics Site during summer 2004: 122 big brown bats (*Eptesicus fuscus*), 100 little brown myotis (*Myotis lucifugus*), 26 red bats (*Lasiurus borealis*), 19 northern myotis (*Myotis septentrionalis*), three hoary bats (*Lasiurus cinereus*), and two eastern pipistrelles (*Pipistrellus subflavus*). Catch was 9.7 bats/net site (*SD* = 10.2) and 2.4 bats/net night (*SD* = 2.6). No bats were captured at two net sites and only one bat was caught at one site; the largest captures were 33, 36, and 37 individuals. Five of six species were caught at two sites, 2.7 (*SD* = 1.4) species were caught per net site, and MacArthur's diversity index was 2.88. Evidence of reproduction was obtained for all species. Chi-square tests indicated no difference in catch of males and reproductive females in any species or all species combined. Evidence was found of two maternity colonies each of big brown bats and little brown myotis. Capture of big brown bats (X^2 = 53.738; *P* <0.001), little brown myotis (X^2 = 21.900; *P* <0.001), and all species combined (X^2 = 49.066; *P* <0.001) was greatest 1 – 2 hours after sunset. Capture of red bats did not vary over the night (X^2 = 7.083; *P* <0.461). Rate of capture was not consistent over the season for big brown bats (X^2 = 28.603; *P* <0.001) or all species combined (X^2 = 10.969; *P* = 0.004), but was similar for little brown myotis (X^2 = 4.184; *P* = 0.123).

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INTRODUCTION

Eleven species of bats are typically considered to occur in Ohio (Gottschang 1981; Belwood 1998; Whitaker and Hamilton 1998): little brown myotis (*Myotis lucifugus*), northern myotis, (*Myotis septentrionalis*), Indiana bat (*Myotis sodalis*), small-footed myotis (*Myotis leibii*), big brown bat (*Eptesicus fuscus*), evening bat (*Nycticeius humeralis*), eastern pipistrelle (*Pipistrellus subflavus*), red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*). Although these species are widespread in the eastern United States, relatively little information is available about the distribution and abundance of these species in Ohio.

The purpose of this paper is to provide documentation of species of bats caught on the 8,665-ha Ravenna Training and Logistics Site (RTLS), Portage and Trumbull counties, OH, their relative abundance, evidence of reproduction and relative abundance of the sexes, periods of night time activity, and relative abundance throughout the summer season. These data are also compared to recent similar studies on military facilities in northern West Virginia, Camp Dawson Collective Training Area (Camp Dawson), and central Indiana, Crane Division, Naval Surface Warfare Center (Crane), and to Hoosier National Forest (HNF), also in central Indiana.

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MATERIALS AND METHODS

Study Area — RTLS is in Portage and Trumbull counties, OH, approximately 3.2 km east of the City of Ravenna and about 48 km southeast of Cleveland (Fig. 1). RTLS is within the Appalachian Plateaus Physiographic Province of northeastern Ohio. More specifically, the site lies within the Killbuck-Glaciated Pittsburgh Plateau. Relief in the region is moderate. Geologic strata are Wisconsinan-aged till over Mississippian and Pennsylvanian-aged shales, sandstones, conglomerates, and coals (ODNR 2005).

The Glaciated Allegheny Plateau lies on the eastern edge of the Beech-Maple Forest Region described by Braun (1950, 1961). This area is generally characterized by the ultimate development of a beech-maple association in which beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) are the dominant canopy species. Small differences in elevation of <1.0 m in this region may result in differences in soil moisture and aeration that influence forest composition. Lower areas where soils are poorly drained support successional swamp forests where white ash (*Fraxinus americana*), red maple (*Acer rubrum*), and American elm (*Ulmus americana*) are representative species. Areas with better soil aeration and slightly higher elevation support drier forest types dominated by sugar maple and upland oak species (*Quercus* spp.).

Of the 8,665 ha on RTLS, 6,475 ha are forested. The RTLS is comprised largely of fragmented habitats stemming from post-successional farmstead and agricultural uses. Mature woodlots and mid-successional upland and lowland forest exist immediately adjacent to inundated/wetland areas. Past maintenance of the area as a military installation further facilitated habitat diversity with creation of ponds, training fields, and

FIGURE 1. Location of Ravenna Training and Logistics Site in Portage and Trumbull counties, Ohio.

numerous corridors (roads and powerline rights-of-way) that may be used by wildlife.

Bat Capture — Mature woodlands and streams suitable for use as travel corridors were identified on topographic maps of RTLS. Circles of 1.0 km diameter were placed over these areas and 28 net sites were chosen corresponding to these circles. Netting was completed 7 June – 10 August 2004. Nets were generally placed in areas used as travel corridors by bats, including streams, trails, and infrequently used roads. Nets were variable in length and 2 – 3 nets (5.2 - 7.8 m) high. Sites were typically netted for two nights with two net sets, although rain and temperature delays resulted in some additional partial nights of netting at some sites; precipitation stopped netting on 9, 14, 17, and 24 June and 14 and 30 July. Surveys were terminated when temperatures fell below 10° C on 19, 20, 23, 25, and 26 June and 6 August. Netting effort totaled 116 net nights. Nets were tended for five hours per night from dusk until approximately 0200 h. Accessible bridges and buildings near survey sites were inspected for roosting bats and guano. Captured bats were identified to species and the sex, reproductive condition, age, mass, length of right forearm, and time and location/net site of capture were recorded.

Data Analysis — Chi-square analysis was used to compare captures of adult males and reproductive females. Chi-square analysis was also used to compare bat capture across five hourly intervals of nightly capture adjusted to time of dusk, and to compare the rate of capture of adult bats during the season by dividing the period 7 June – 10 August into 3 equal periods and weighting the periods by level of effort. A species diversity index (SDI) was calculated: $SDI = 1/\sum P_i^2$ (MacArthur 1972), where P_i is the proportion of bats belonging to species i in each sample. Capture was also assessed by catch per net night, per net site, species per site, and number of sites that caught bats.

RESULTS

Six species, 272 individuals, were represented in the sample (Table 1): 122 big brown bats, 100 little brown myotis, 26 red bats, 19 northern myotis, three hoary bats, and two eastern pipistrelles. Nine bats escaped before sex and morphometric data were collected, although each was identified to species. The mean rate of capture was 9.7 bats/net site (*SD* = 10.2) and 2.4 bats/net night (*SD* = 2.6). No bats were captured at two net sites, and only one bat was caught at one site, whereas the greatest number of bats captured at a site was 33, 36, and 37 individuals. There was no evidence that bats roosted in any man-made structure inspected.

Species richness was highest at two sites where five species were caught; 2.7 (*SD* = 1.4) species were caught per net site, and the species diversity index was 2.88. The big brown bat was the most commonly captured species (45% of catch), whereas the little brown myotis was caught at the most sites (79% of sites; Table 2). Similarly, the northern myotis and red bat were caught at over 50% of sites sampled. Chi-square analysis confirmed that species were not evenly represented in the sample (X^2 = 214.17, P <0.001).

Evidence of reproduction, juveniles or pregnant, lactating or post-lactating females, was obtained for all species. Chi-square tests indicated there was no difference in the catch of adult males and reproductive females in any species or for all species combined (Table 1). Capture of 17 reproductive females and 2 juvenile big brown bats at one site and six reproductive females and 16 juveniles at a second site indicated that maternity colonies were nearby. Similarly, captures at two sites indicated that maternity colonies of little brown myotis were nearby: nine reproductive females and two juveniles were caught at one site, and five reproductive females and 12 juveniles at the second.

The rate of capture over five hours of sampling was different than random for the big brown bat, little brown myotis, and for all species combined (Table 2). Captures were greatest between one and two hours after sunset. Captures were least during the fourth period, but began to increase during the last hour of sampling. The rate of capture over the season was not consistent for the big brown bat (X^2 = 28.603; P <0.001) or for all species combined (X^2 = 10.969; P = 0.004), but was similar for the little brown myotis (X^2 = 4.184; P = 0.123).

DISCUSSION

Although 11 species of bats are considered resident in Ohio (Gottschang 1981; Belwood 1998; Whitaker and Hamilton 1998), only six were found at RTLS, Portage and Trumbull counties, during summer 2004. However, the remaining five species are rare or uncommon. No federally endangered Indiana bats were caught. Silver-haired bats are most likely to be caught as migrants

TABLE 1

Bat captures for adult males, pregnant (P), lactating (L), post-lactating (PL), and juvenile (Juv) bats caught on RTLS in summer 2004. Bats identified to species but which escaped before sex and morphometric data were collected are noted. A Chi-square test of equality of catch by adult males and reproductive females is provided by species.

Species	Male	P	L	PL	NR	Juv	Escape	Total	X^2	*P-value*
Big brown	37	5	5	44	4	23	4	122	3.176	0.075
Little brown	30	2	3	29	5	30	1	100	0.250	0.617
Northern	10	0	0	5	1	3	0	19	1.667	0.197
Red	6	0	2	5	0	10	3	26	0.077	0.782
Hoary	0	0	0	0	0	3	0	3		
E. pipistrelle	0	0	0	1	0	0	1	2		
Total	83	7	10	84	10	69	9	272	1.761	0.185

during spring and autumn. Rafinesque's big-eared bat and the eastern small-footed myotis are probably accidental or vagrants in the state. The evening bat is rarely encountered in Ohio, and the status is undetermined. It roosts in both natural (tree) roosts and in buildings.

Big Brown Bat — The big brown bat was the most frequently caught species. Their capture was greatest 1 – 2 hours after dark and may reflect the time when insects are most abundant (Brack and LaVal 1985). Similarly, in Indiana (Brack 1985) and Michigan (Brack and others 1984), catch was greater during the first half of the night. More adult big brown bats were caught mid season than early and late in the season, which may reflect the communal nature of the species. Similar numbers of adult males and reproductive females were caught, although captures of reproductive females and juveniles were concentrated in two areas where there were maternity colonies, whereas capture of adult males was more dispersed. In Pennsylvania, females were more common than males at lower elevations (Brack and others 2002). On Hoosier National Forest (HNF) in south central Indiana, males were more common than females, and the rate of catch was much less than on RTLS, apparently because maternity colonies are often in buildings, which were uncommon in areas netted on HNF (Brack and others 2004).

The big brown bat is a generalist in the type of habitats frequented, explaining its capture at many locations across RTLS, although the species often eats heavily chitinized insects. In Clermont County, OH, coleopterans

TABLE 2

Number and percent of 28 net sites where bats were caught, capture during each of five 1-hour time frames (T1 – T5) of netting beginning at dusk, and Chi-square analysis of the evenness of catch across those 5 periods.

	No./% Sites	T1	T2	T3	T4	T5	X^2	*P-value*
Big brown	20/71%	27	55	14	13	13	53.738	0.000
Little brown	22/79%	10	37	20	13	20	21.900	0.000
Northern	14/50%	4	0	7	2	6		
Red	16/57%	8	6	3	3	6	7.308	0.461
Hoary	3/11%	0	1	2	0	0		
E. pipistrelle	2/7%	1	0	0	1	0		
Total	26/93%	50	99	46	32	45	49.066	0.000

and hymenopterans were most frequently eaten (Brack and Finni 1987). On Crane Division, Naval Surface Warfare Center (Crane) in central Indiana, the diet of the big brown bat was 75% coleopterans, including Asiatic oak weevils (*Cyrtepistomus castaneus*; 13.9%) and spotted cucumber beetles (*Diabrotica undecimpunctata*; 8.3%), and a green Pentatomidae (Order Hemiptera) was 18.3% of the diet (Brack and Whitaker 2004). The big brown bat feeds heavily on agricultural pest insects (Whitaker 1995).

Little Brown Myotis — Although the little brown myotis is one of the most widespread species in North America, its abundance varies considerably from locality to locality. It was caught at the most sites on RTLS and was the second most abundant species. Captures of reproductive females (and juveniles) were more clumped than were captures of adult males, but overall captures were similar. In Pennsylvania, Virginia, and West Virginia females were less common than males at higher elevations (Brack and others 2002). On Crane, the catch of adult males was greater than that of reproductive females (Brack and Whitaker 2004), although no such disparity was apparent in nearby HNF (Brack and others 2004).

The rate of capture of bats across the season can be a concern for some species, especially if sampling should be completed when a rare species is most abundant, for example the congenera Indiana bat. On RTLS, capture of little brown myotis did not vary across the season, and did not substantiate a concern that sampling may produce better results during specific portions of the summer.

The little brown myotis is sometimes considered more common along streams and near bodies of water. This was true in southern Indiana in HNF (Brack and others 2004). The little brown myotis exhibits a great deal of variation in its diet, but often feeds on aquatic insects and is loosely described as a dipteran-lepidopteran-coleopteran feeder (Belwood and Fenton 1976; Buchler 1976; Anthony and Kunz 1977). On Crane, the diet was dominated by lepidopterans, coleopterans, and trichopterans; the spotted cucumber beetle was 5.3% of the diet (Brack and Whitaker 2004).

Northern Myotis — The northern myotis is a common component of the woodland chiropterafauna of much of eastern North America. Summer maternity colonies are usually under sloughing bark or in cracks of trees (Lacki and Schwierjohann 2001). Similar numbers of reproductive females and males were caught on RTLS, although in some portions of its range, females are more common at higher elevations (Brack and others 2002). In Missouri and Indiana, Brack and Whitaker (2001) reported that this species was active throughout the night and that it was more abundant at non-riparian sites; on Camp Dawson in northern West Virginia, the northern myotis was more commonly caught at upland sites (Brack and others 2005). In Missouri and Indiana, lepidopterans were most important in the diet, followed by coleopterans, trichopterans, and dipterans (Brack and Whitaker 2001). Spiders, probably consumed while gleaning, were the second most important food in the diet on Crane; lepidopterans comprised >60% of the diet (Brack and Whitaker 2004).

Red Bat — The red bat is a common summer resident of much of the eastern United States, including Ohio, and uses a variety of woodland habitats. It is a seasonal migrant, but some individuals apparently remain in the state during winter, although individuals may not be year-round residents. Catch of adult males was similar to catch of reproductive females, unlike HNF, where reproductive females were more common (Brack and others 2004), and Camp Dawson where males were more common (Brack and others 2005). Differences in sex ratios of red bats have been attributed to migratory patterns (LaVal and LaVal 1979), but in West Virginia, Brack and others (2002) found an inverse relationship between reproductive females and elevation; higher elevations are cooler, wetter, and have more variable temperatures. Ford and others (2001), looking at museum specimens, found that male red bats dominated in the Appalachian Highlands where mean monthly temperature in June fell below 28.5° C. Similar to studies in Clermont County, OH (Brack and Finni 1987), Crane (Brack and Whitaker 2004), and southern Michigan (Brack and others 1984), catch of red bats on RTLS was not concentrated in any portion of the night, although on Camp Dawson, capture of red bats was bimodal with peaks at dusk and again about the fifth hour (Brack and others 2005).

Red bats feed on a variety of insects (Brack 1985; Whitaker 1972), but moths often form much of the diet (Whitaker and others 1997), which is reflective of the woodland habitats they occupy. The diet of this bat in Clermont County, OH, was comprised of lepidopterans (42%), coleopterans (30%), homopterans (10%), dipterans (9%), and neuropterans (7%) (Brack and Finni 1987). On Crane, moths were 51% of foods eaten, followed by two types of coleopterans, Asiatic oak weevils (30%), and scarab beetles (11%) (Brack and Whitaker 2004).

Hoary Bat — This summer woodland resident is not common anywhere in Ohio (Gottschang 1966), or elsewhere throughout its very wide geographic distribution. Only three individuals, all juveniles, were caught, providing evidence of reproduction on RTLS. Early studies considered the hoary bat a moth specialist (Black 1972), but this was not true in Clermont County, OH (Brack and Finni 1987), on Crane (Brack and Whitaker 2004), or in other portions of Indiana (Brack 1985).

Eastern Pipistrelle — Only two eastern pipistrelles were caught, although the species is widespread in the eastern United States. In Ohio, Gottschang (1981) and Belwood (1998) indicated that the species is least common in the northwestern portion of the state. This species sometimes forms small maternity colonies in buildings, but most colonies are located in clusters of dead or living leaves (Veilleux and others 2003). Proximity of summer and winter habitat is apparently necessary. In Indiana, the species is uncommon north of the Wisconsin glacial limit (Brack and Mumford 1984). This is apparently because a close geographic association of winter hibernacula and summer habitat is important (Whitaker and Hamilton 1998). The diet of

the eastern pipistrelle is varied (Brack 1985). In Clermont County, OH, insects belonging to six orders were eaten (Brack and Finni 1987). On Crane, eastern pipistrelles ate lepidopterans, coleopterans, dipterans, and homopterans; Asiatic oak weevils were 8.4% of the diet (Brack and Whitaker 2004).

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